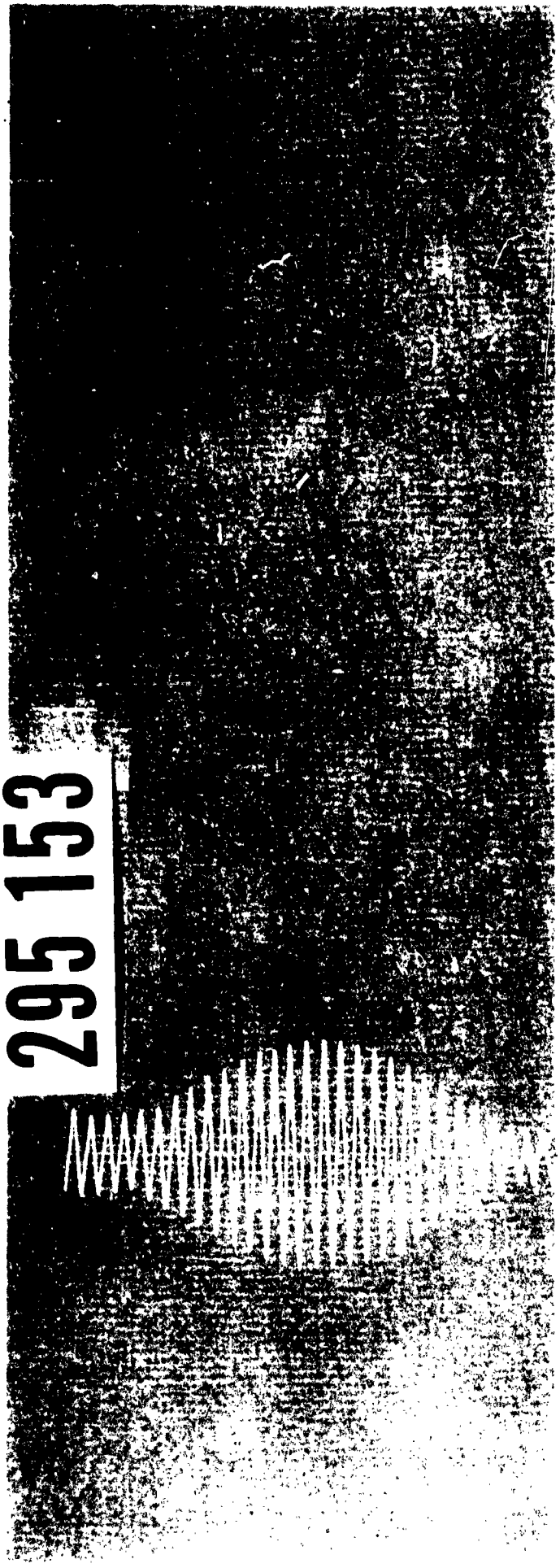
63-2-3



VARACTOR DIODE INDUSTRIAL PREPAREDNESS MEASURES

10TH QUARTERLY PROGRESS REPORT

25 SEPTEMBER 1962 through 25 DECEMBER 1962

MICROWAVE ASSOCIATES INC.

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10TH QUARTERLY PROGRESS REPORT

25 SEPTEMBER 1962 through 25 DECEMBER 1962

Signal Corps Contract No. DA36-039 SC-85941

Signal Corps Technical Requirements No. SCS-63

Dated 21 September 1959

Signal Corps Supply Agency
225 South 18th Street
Philadelphia 3, Pennsylvania

MICROWAVE ASSOCIATES, INC.

Burlington, Massachusetts

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SECTION I - PURPOSE

The purpose of this contract is the establishment of a capability to mass-produce a variable capacitance microwave diode. This diode, known as a "varactor diode", is a silicon diffused mesa device.

SECTION II - ABSTRACT

A method of measuring the series resistance of a glass Type III varactor diode is presented. A similar method has been independently developed elsewhere and is described in Ref. 1.

The measurement is based on a determination of the transmission loss due to inserting a diode in a shunt with a transmission line. The transmission loss, maximized by series tuning of the diode, is converted to series resistance in ohms through use of a conversion graph.

SECTION III - PUBLICATIONS AND REPORTS

No publications connected with this contract were made during the interval covered by this contract.

SECTION IV - FACTUAL DATA

A. Circuit Description - 1120 Mc Rs Measurement

A block diagram of the circuit used is shown in Fig. 1. The varactor holder (Fig. 3) is in the form of a tee having Type N coaxial connectors on two ends of an open rectangler box and

another Type N connector on one side. The varactor is placed between the center conductor slabs and secured by nylon screws.

The detector circuit as shown in Fig. 2 is built in a General Radio Insertion Unit. A Microwave Associates MA-3055 circulator is used as an isolator before the detector.

The minimized signal level at the detector is a function of the R_s of the diode. R_s is thus seen to be determined in this test by measuring the transmission loss. The reference level is set by replacing the diode with a short circuit and maximizing the transmission. This step is not very critically dependent upon the resistance of the short circuit or of the adjustable short and is distinct from the measurement of the resistance of the adjustabe short.

The reflection loss of a varactor is determined by measuring the difference in decibels between the maximum signal setting of the shorting stub tuner and the minimum signal setting of the tuner. The series resistance is then determined from the formula

$$R_s = \frac{25}{\text{Loss (voltage ratio)} - 1} \qquad \text{Eq. (1)}$$

where

$$\text{Loss (voltage ratio)} = \text{antilog}_{10} \frac{\text{db down}}{20} \qquad \text{Eq. (2)}$$

A tubulation of Equation (1) db vs. R_s is supplied in Table I. and curves for these values are shown in Figs. 4, 5.

The resistance of the sliding contacts of the adjustable short circuit is determined from the apparent resistance value measured for a slab short. The resistance of the sliding contact should be subtracted to obtain the varactor resistance. This is a conservative porcedure since the presence of capacitive reactance actually magnifies the effect of the resistance of the sliding contacts.

B. OPERATION

1. Set up apparatus as shown in Fig. 1 block diagram.

2. Operate the HP Model 612A in accordance with instruction manual (Sec. II, Page 2-9, Para. 2-7) for operation with external modulation.

3. Set the Eico Model 377 Audio Oscillator at 1000 cycles with the output selector on square wave modulation.

4. Adjust the HP 415B standing wave amplifier step switch to the 30 scale and turn the gain control full on to its extreme clockwise position.

5. Adjust the frequency of the HP 612A signal generator to 1120 Mc/sec.

6. Place a slab short in the varactor holder under the nylon mounting screws.

7. Adjust the signal generator output attenuator and the Microlab tuner until a signal is observed.

8. Maximize the signal through the Microlab tuner and lock. Slight adjustments of the modulation and output controls of HP 612A may be necessary during tuning.

9. Observe that adjusting the GR 874 D50 tuneable short tunes the signal through a maximum and minimum. With the tuner at a maximum the output attenuator of the HP 612A should be adjusted to give a full scale signal reading on the 30 db step of the HP 415B amplifier. Under these tuned conditions the output attenuator of the HP 612A should approximate a 25 db value.

10. The kit is now ready for test use.

C. TEST PROCEDURE

1. Secure diode in mount.
2. Move short until a minimum is obtained on amplifier. Switch steps when necessary to read minimum value in terms of db change max. to min.
3. From chart of db vs R_s obtain series resistance value.
4. Subtract R_s value of slab short from R_s in step 3 to obtain R_s value of diode.

Ref. 1 5th Interim Report on Microwave Solid State Devices - Contract #DA36-039-SC-85325 with Bell Telephone Laboratories.

SECTION IV - PROGRAM FOR NEXT QUARTER

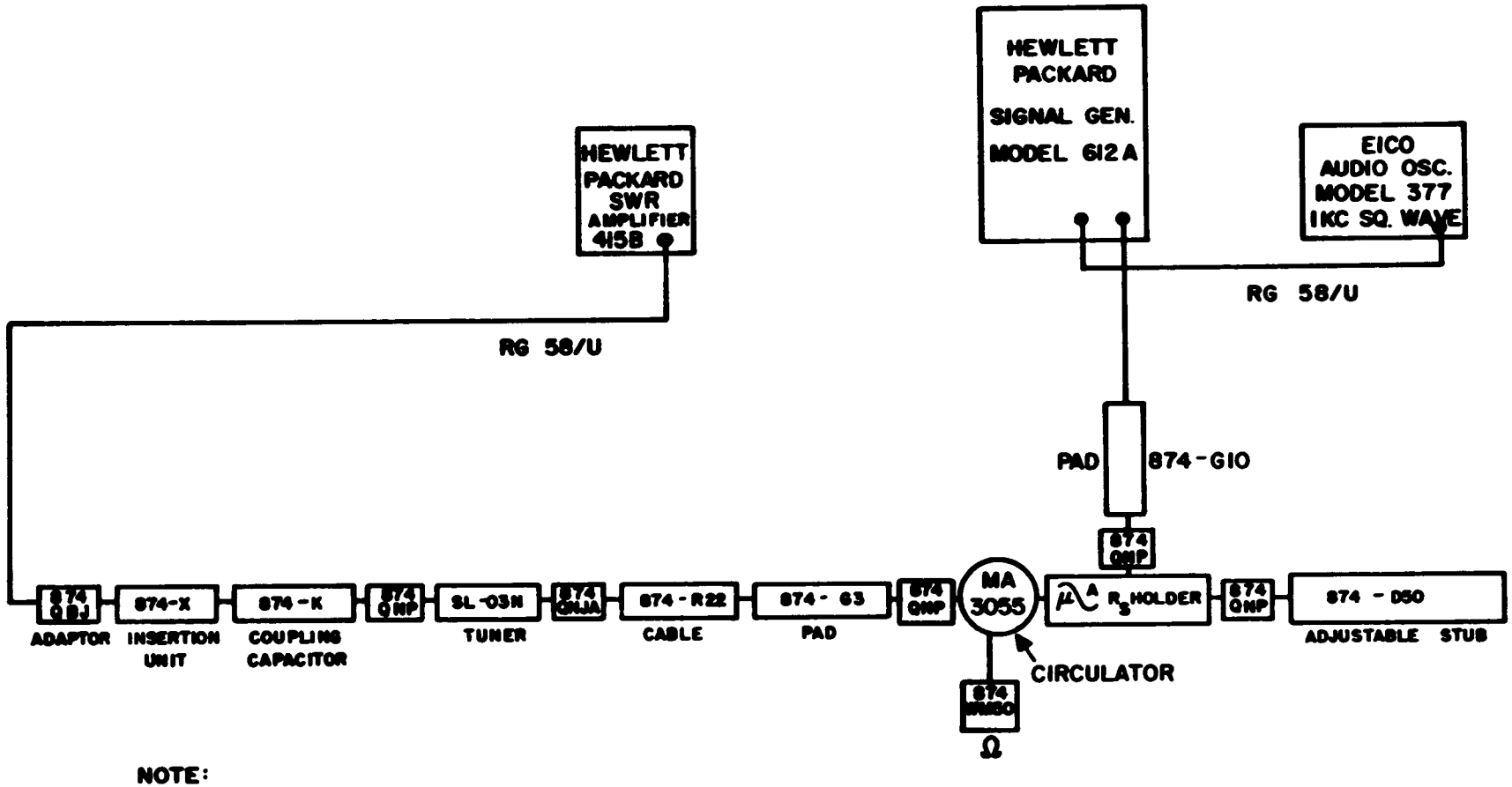
In the next quarter more work will be performed on the measuring of cut-off frequency (R_s) of varactor diodes.

SECTION VI - KEY PERSONNEL

	Man Hours
1. D. Brewster	60
2. F. Kupriss	50
3. N. Prasinos	100
4. D. Revelotis	240

TABLE I.

db	R_s	db	R_s
1	223.	26	1.32
2	96.8	27	1.18
3	60.6	28	1.04
4	42.8	29	0.93
5	32.2	30	0.82
6	25.0	31	0.73
7	20.5	32	0.64
8	16.6	33	0.575
9	13.75	34	0.51
10	11.65	35	0.455
11	9.88	36	0.40
12	8.44		
13	7.26		
14	6.26		
15	5.44		
16	4.75		
17	4.14		
18	3.63		
19	3.18		
20	2.80		
21	2.48		
22	2.16		
23	1.92		
24	1.68		
25	1.50		



NOTE:

1. ALL 874 TYPES ARE MFG. BY GENERAL RADIO CO.

2. SL 03N MFG. BY MICROLAB

FIGURE 1

BLOCK DIAGRAM FOR SERIES RESISTANCE TEST

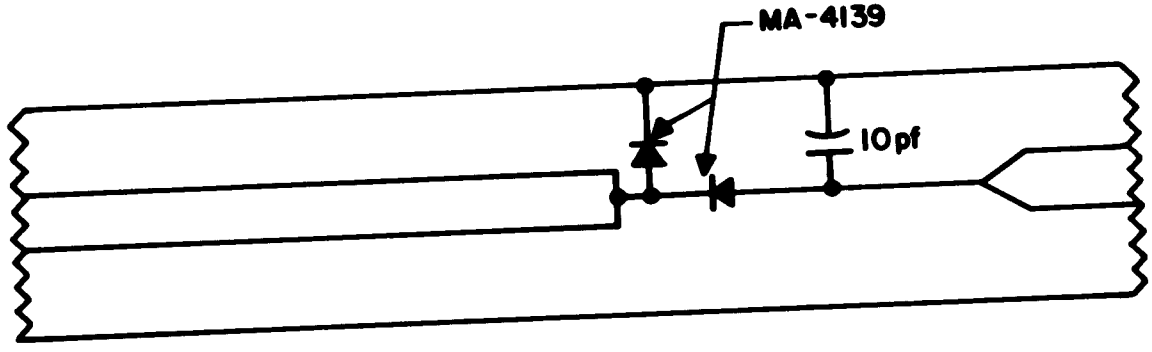


FIGURE 2

DETECTOR CIRCUIT

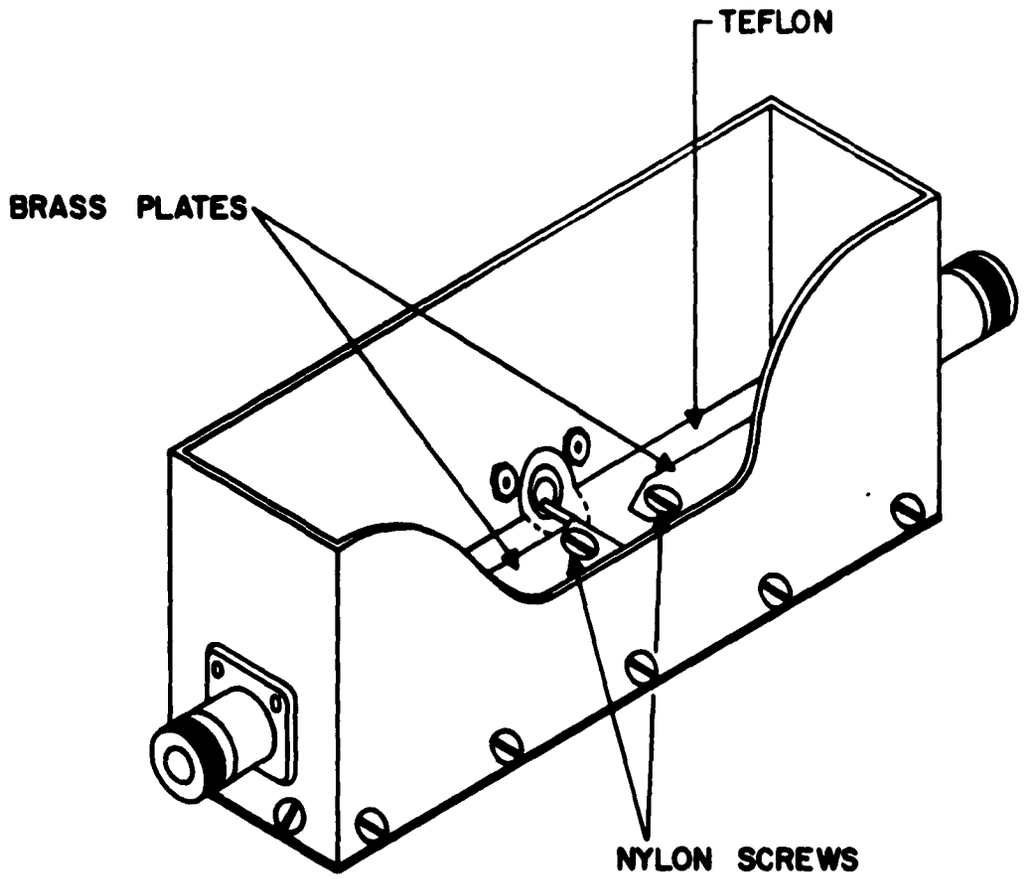
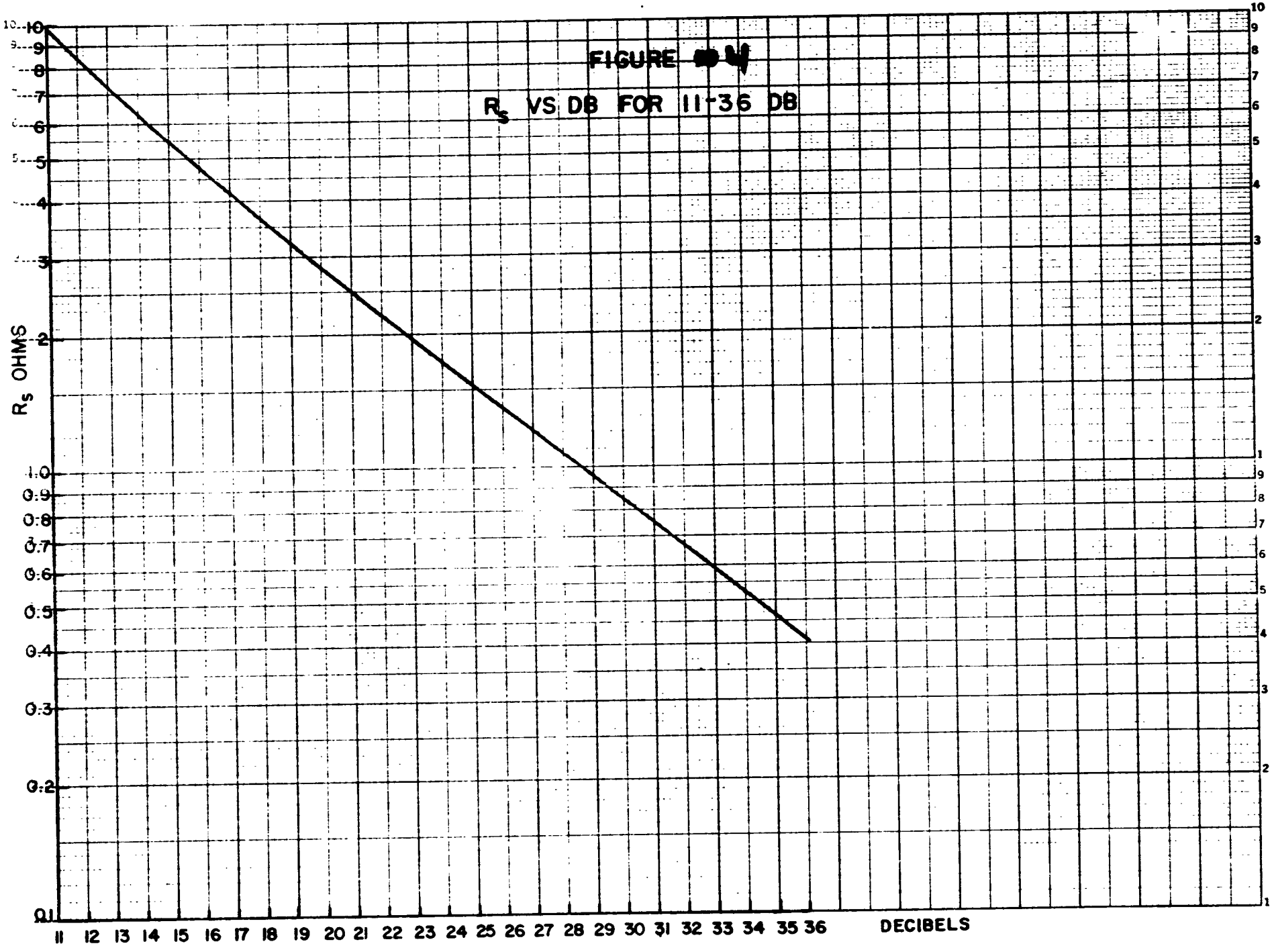


FIGURE 3

SERIES RESISTANCE MOUNT

SEMI-LOGARITHMIC 359-64



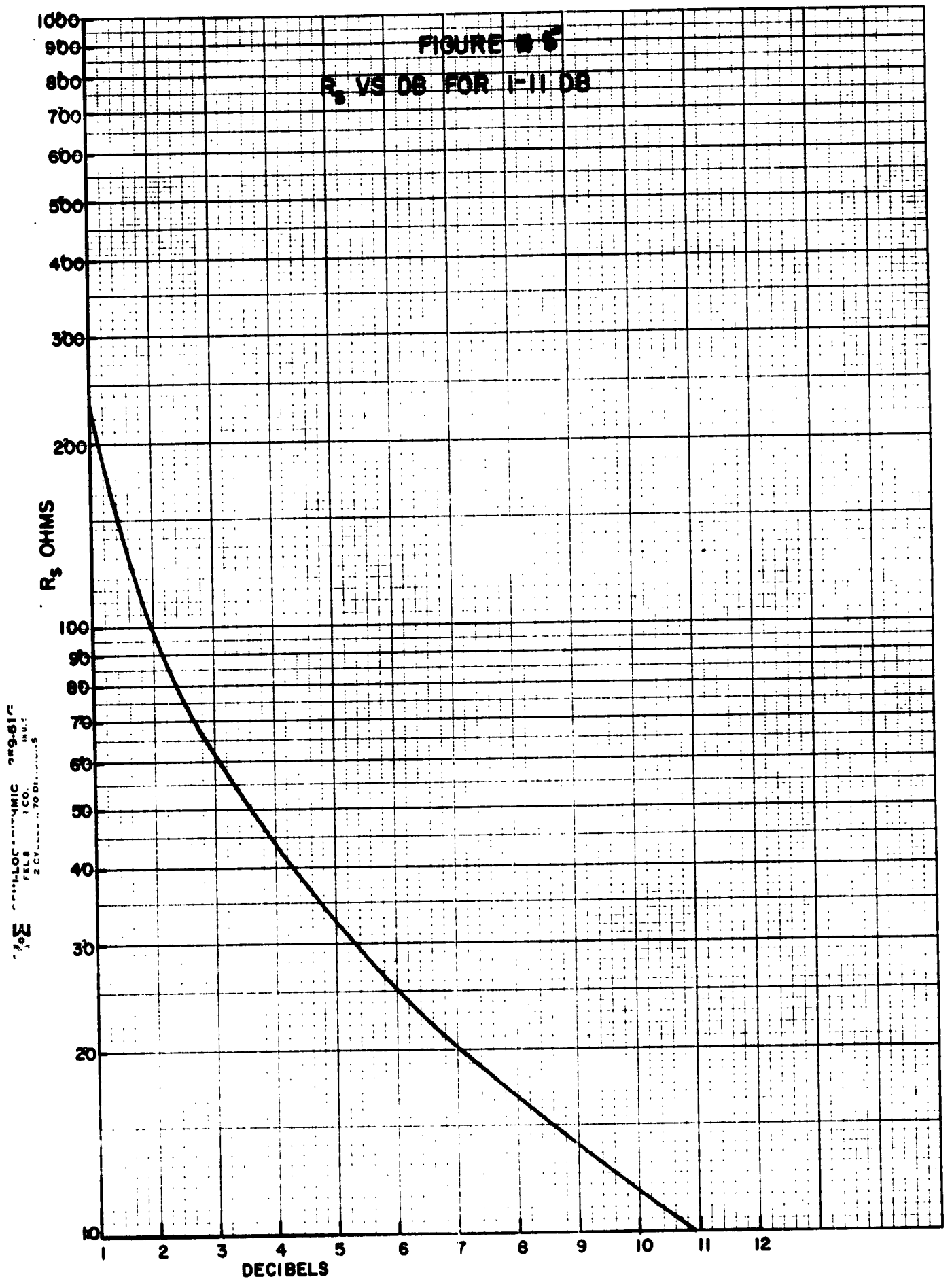


FIGURE 8-5
R_s VS DB FOR 1-11 DB
R_s OHMS
1000
900
800
700
600
500
400
300
200
100
90
80
70
60
50
40
30
20
10
1
2
3
4
5
6
7
8
9
10
11
12
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